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Fig. 1.



Fig. 2.

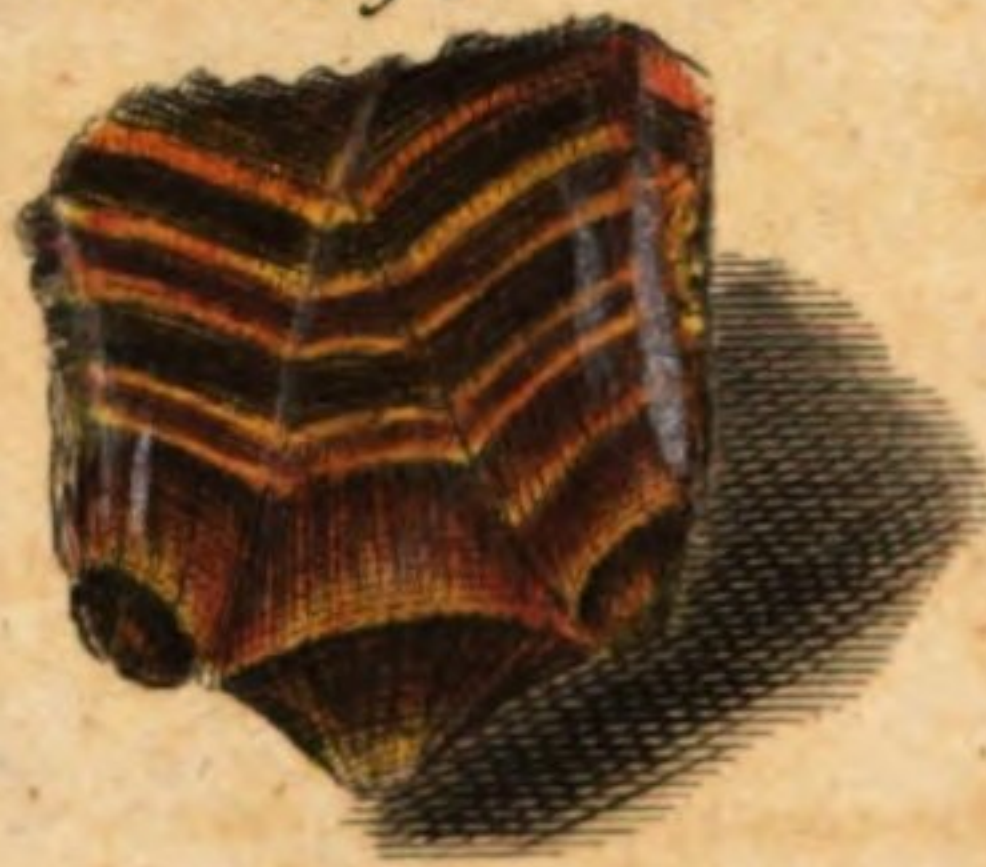


Fig. 3.



OBSERVATIONS
RELATIVE TO THE
MINERALOGICAL AND CHEMICAL
HISTORY
OF THE
FOSSILS OF CORNWALL.

By MARTIN HENRY KLAPROTH,

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CARIES, AND EXTRAORDINARY MEMBER OF THE FRIEND-
LY SOCIETY OF INQUIRERS INTO NATURE, OF BERLIN.

TRANSLATED FROM THE GERMAN

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OBSELYATIONS

MINERALOGICAL AND CRISTALLOGICAL

NISTORY

FOSSILS OF CORNWALL

BY MARTIN HENRY BUCHANAN

WITH A DESCRIPTION OF THE FOSSILS OF THE
CORNWALL MUSEUM, AND A
LIST OF THE FOSSILS OF THE
CORNWALL MUSEUM

THE
CORNWALL MUSEUM
CORNWALL

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München

ADVERTISEMENT.

THE work of which a translation is now presented to the public, was published about two months ago in the *Schriften Natur-Forschender Freunde*, of Berlin. The Author of it is distinguished in Germany for the extent and accuracy of his Chemical and Mineralogical knowledge; and nothing more than his being known seems necessary to procure him a similar distinction in other countries.

The Translator confesses that one object of his undertaking has been to make Mr. Klaproth's merit more generally known; at the same time he persuades himself that his performance
may

may be of some amusement and use to the English Naturalist, in giving him a more accurate description and analysis of minerals of his own country, than has yet appeared in the English language. He would hope too that it may render some service to the sciences of Chemistry and Mineralogy, the interests of which cannot fail to be promoted, by diffusing the knowledge of every thing which respects them; it may, accidentally, perhaps, increase the number of those who study these sciences, and excite a spirit of greater diligence and precision in researches connected with them.

The Translator is not certain, whether it may not be proper for him to say something by way of vindication of the Author, and something by way of apology

logy for himself. Though he is not aware of any error in the sketch of the Natural History of Cornwall, which is given in the following work, that sketch would certainly have been more full, and it might have been more exact, if the Author had had the benefit of seeing the country, the minerals of which he describes. As he was without that advantage, he has been obliged to depend upon the relations of others, and his own collection of Minerals. But both of these the Translator has the best reason for believing have been remarkably accurate and complete. If, however, there should be any imperfection in this part of the Author's work, he is confident it has been unavoidable, and cannot therefore be imputed to the Author as a fault.

He

viii A D V E R T I S E M E N T.

He wishes he could believe that his own apology was not more necessary than the Author's vindication; but he is very sensible that the translation has many defects, and defects which are not easily excused. It may not, however, be unreasonable to expect some indulgence to the work of a foreigner, who, during a short stay in England, has been able to form only an imperfect acquaintance with the English language; and the translation of a work of science should not, perhaps, be absolutely condemned, if it be sufficiently perspicuous to convey the meaning of the original, although it be deficient in ease and in elegance.

London,
Nov. 10, 1786.

INTRO.

INTRODUCTION.

THE County of Cornwall claims the peculiar attention of mineralogists, on account of its subterraneous natural productions. No country in the world can boast of mines more ancient, or productive for a longer period. For before the time of Herodotus, the Phœnicians, and after them the Greeks, brought tin from this country, which, on that account, was named by the latter nation Cassiterios, or the Tin-island: and with respect to the present richness of these mines, instances will be given in the course of this work, of the profit of single mines, which shew, that it is not an exaggerated account which Mr. Jars gave in the year 1770, that the value of the annual produce of the tin-mines amounts from 190 to 200,000
B pounds,

pounds, and of those of copper to 140,000 pounds sterling; and there is still an abundant store of both metals to last for many centuries.

The peculiarity of most of the Cornish fossils affords the naturalist a fruitful subject of enquiry, and rich materials for the increase of geological and mineralogical knowledge. Becher, perhaps, the most experienced mineralogist and miner of his time, who had studied subterraneous nature in the mines of Hungary and Germany for many years, acknowledges freely that he still found a great deal to learn in Cornwall. He expresses himself (in the remarkable dedicatory epistle to the famous Boyle, of his Mineralogical Alphabet, which he wrote at Truro, in Cornwall,) in the following manner: "The earth is here so abundant in different kind of fossils, that I believe there is no place in the world which excels Cornwall in the quantity and variety of them: and I confess

confess I have found here a mining-school, and from being a teacher am become a scholar." And soon after he says, "I could never have written any thing solid in chemistry, without having seen so much of Cornwall." This our German countryman made the most important improvements in working mines, and extracting metals in Cornwall: among other improvements, he first introduced there the machines for draining mines, and the use of pit-coals for the melting of minerals.

Since his time these mines have been only rarely visited and described by foreign naturalists, so that the knowledge of the fossils belonging to them is not yet so general as it merits. In the works of English authors, *e. g.* Woodward's History of Fossils, and Borlase's History of Cornwall, the fossils of Cornwall have been treated of, but not with sufficient mineralogical, and with still less chemical knowledge, which in the

times of those writers was every where defective. But, at present, as the British nation has begun to produce in this department of science also men of merit and activity, who advance with laudable ardour mineralogy and chemistry in their own country, we may expect important additions to both these branches of natural knowledge. In the mean time I will give as a sketch, the following small additions to the knowledge of some curious, and in some respect, little known fossils of Cornwall, which I received from my worthy friend, John Hawkins, Esq. with whom I had the pleasure of making some of the following analyses.

MINE-

MINERALOGICAL
OBSERVATIONS.

TIN ORES.

WHETHER true native tin has ever been found, as some mineralogists have asserted, is a question not yet determined, even in Cornwall. On the contrary, it is rather thought that those pieces of metallic tin, which have been found there, are only a production of art.

The common tin ores are in a calcliform, and at the same time indurated glass-like state, more or less mixed with calx of iron, and commonly joined also with ores of arsenic. *Zinstein*, (Tin-stone,) might be the general denomination of them, but commonly only the

irregular and compact species are called so. The crystallized tin-stones, on the contrary, are called *Zinngraupen*, if the crystals are distinct, and somewhat large; but *Zinnzwitter*, if the crystals are smaller, and not so distinct, resembling small grains, scattered through a compact raw tin-stone, or a stone of any other kind.

These species of Cornish tin-ores differ from those of Bohemia and Saxony principally in this, that in general they contain less iron and less arsenic; and this is the cause of the preference the English tin in general obtains, on account of its purity.

The common matrix is Killas and Growan. A description of both is to be found in Mr. Kirvan's mineralogy. Growan consists of white clay, mixed with mica and quartz, and is of no peculiar texture: it is, therefore, nothing else but decayed granite, in which the Feldspat has been broke down into clay.

Killas,

Killas, which might be justly called *Saxum metalliferum cornubiense*, has been classed by Mr. Kirvan, under the horn-stones; he found 100 grains of the grey lamellar killas to contain about 60 of filex, 25 of argill, nine of magnesia, and six of iron. The greenish sort contains more iron. Some of the crystallizations of the *Zinngraupe*n from Cornwall are very remarkable. The most regular, but which are found only rarely, are quadrangular prisms, with double quadrangular pyramids: there are some also where the prism is wanting, and both pyramids are joined together by their bases, so that the crystal is octoedral. Such regular crystals are found at Trevaunance and Soil-hole, in the parish of St. Agnes. Similar quadrangular prismatical crystals, very tender, and often only of the thickness of a hair, are found in tin-stone upon killas, at Polgooth, one of the richest tin mines, which at this time produces monthly a clear profit of

from 1000 to 1200 pounds sterling. The two crystallizations which have been mentioned are the bases of all others, though these, by their extremities and angles being truncated, and by their being variously grown together, commonly appear very irregular. The fine polish most of these tin-crystals have gives them a peculiar beauty, which is often heightened by a certain degree of transparency. Such transparent crystals, in what is called Elvan, a species of argillaceous shiste, are found at Kreegbraws in Kenwyn. The rays of light passing through gives them a bright brown-reddish gloss, for which reason the miners in Cornwall call them Rosin-tin. Tin crystals of very glossy appearance, but on account of a larger proportion of iron, of a quite dark black colour, are found at Poldice.

These species of tin-ores give a peculiarly good tin, because they are the most free from arsenical pyrites. Among my specimens there are only a few which are
mixed

mixed with arsenic and interspersed through yellow copper ore; these are from Poldice. The tin ores from Huel Brea Load, in the parish of St. Ives, and from Cornellow Cliff, in Zennor, are united to shoerl. In those from the former place the tin-stones are like a heap of crystals of different sizes interwoven with a compact, finely radiated greenish grey shoerl nestways in granite: But from the latter place I have specimens of blackish *Zinnzwitter* in a vein only half an inch thick, the walls of which are a fine shoerl.

In another tin vein at Pelmine, in the parish of St. Agnes, the thickness of which is one inch and a quarter, both walls consist of pretty large tin crystals of a light greyish yellow colour, by means of which the vein is very evenly separated from the rock: the spaces between the tin crystals are filled up by a reddish white quartz.

Tin-

Tin-stone with wolfram is found at Wheal Mutterel, in Gwennap.

Zinngrauen, both of large and middle sizes, in double quadrangular pyramids, so as to form what is called *Visirgrauen*, the crystals of which have lost something of their gloss and sharpness of angles are found at Bun-mine, in St. Austle, in much decayed granite or growan. Other species of rich tin-stones and *Zinn-zwitter* are found at Mainvrose and Mengarn in Wendron, Trethallan in St. Stevens, and Huel Malkin. The tin-stone from the latter place is formed by very small clear white grey tin crystals, grown intimately together, with very fine, mostly greenish particles of mica. In some places the tin-stone has fissures, the cavities of which are lined with small tin crystals, of a garnet form; now and then it is run through with small veins of red jasper, and contains nodules of it.

STREAM-

STREAM-TIN.

Not only the above-mentioned tin-stones, which are taken out of veins, produce metal, but likewise what are obtained from stream works, similar to those in Germany, yield a considerable quantity of rich tin ores. The manner of streaming or collecting the tin rubbles, with which the valleys of the tin mountains in Cornwall are filled in great abundance, and to considerable depth, is briefly the following; the soil of such valleys is dug several feet deep to the tin stratum, and, by water led over, washed of all the waste. It is very probable that violent torrents of water have broke these tin rubbles from the original veins of the tin mountains, and rolled them down the declivities of hills into the lower grounds. Mr. Jars, indeed, believes these fragments to be remains of heaps of refuse, from the ancient unskilful working of the mines, which by inundations have been washed down

down from the mountains, and formed beds in the valleys.

This stream-tin is found of different size, colour, and figure, but most commonly rounded by water, and very like the common pebble, excepting in its very considerable weight.

The stream-tin collected at Ladock principally consists of such round, oval, somewhat smooth pieces, in general from the size of a bean to that of a pea, and less, whose polished surfaces shew great variety of reddish grey, light brown, and dark yellow colours.

A similar stream-tin from Pensagillis is remarkable on account of the native gold, which now and then is met with in it; and found, though very rare, in pieces of the value of two or three pounds sterling. In my collection from this place is a grain of native gold, of the size of a flattened pea, with a crystallized surface. Probably in ancient times there were in these hills veins of gold, which have been broken down by violent inundations.

Stream-

Stream-tin in blackish rough grains is found at Perran Porth in Perranzabulo, where it lies some yards under the sea-sand, and therefore can be collected only at the time of low-water.

It is found at Hallibefack in Wendron, Frogmoor in Probus, at Saint Denis and Roach in larger and less rounded pieces, many of them still shewing their crystallized angles. The specimens of stream-tin, from Swan-Pool in the parish of Ladock, are often mixed with pieces of cubic galena.

The most remarkable species of stream-tin is a tin-ore like haematites, or what is called Wood-tin. This tin-ore is only found within a small circuit, in the three adjoining parishes of Saint Columb, Roach and Saint Denis, and is very scarce. The most favourable opportunity of getting it is at the time when the workmen, who stream the tin, bring to the melting-houses the quantity of ore they have collected during three or four months; amongst

amongst this we may seek for, and expect to meet with, wood-tin.

This rare tin-ore, which is entirely without the crytallized form proper to tin-ores, and on the contrary resembles very much haematites, is not, as it at first appears, a true haematites, with which some tin is mixed, but a true and rich tin-ore, in which the portion of iron common to all tin-ores is only in an inconsiderable quantity, as will be seen plainly in the chemical analyses to be mentioned afterwards.

Professor Brunnich, of Copenhagen, is, as far as I know, the first who made this mineral known, and I shall copy therefore his words from a dissertation inserted in the Memoirs of the Royal Swedish Academy of Sciences for the year 1778, under the title of *A Description of two tin-ores from Cornwall*. “The other species is very rarely found, and is called in Cornwall Woodlike tin-ore. It has fine fibres, converging to different centres,
like

like the radiated zeolyte, but it is so compact and hard, that it gives sparks when struck with steel. In mineral acids it is not considerably dissolved. Broken in pieces it shews conical figures, and preserves its fibrous appearance till it is powdered. The general colour is yellowish, with concentric lines of lighter and darker colours, and some quite black. I have not yet seen any one of this kind in its perfect form, but always in broken pieces, either of hollow spheres or of solid ones, having a blackish brown crust upon their external surface, which is smooth and spherical like some haematites: pieces which are possessed of this crust are very rare. Sometimes there is a little white quartz joined to them. They are never found in veins or fissures of any considerable depth in the solid rock, but only washed together in the valleys, which may be seen indeed by their rounded surfaces. The specific gravity with respect to water at about 45 degrees of heat,

heat, according to Fahrenheit, is as 580 : 100. It gives 34 parts of tin in 100; when roasted it gives some sign of arsenic; the yellow colour changes to a reddish; and when thus changed, a small part is attractable by the magnet. I received this mineral from Mingums near Saint Columb, and from Saint Denis in Cornwall. I call it radiated yellow tin ore."

This description of Mr. Brunnich is just, except with respect to the specific gravity of the ore, and the quantity of tin contained in it. The first is, according to my hydrostatical experiments with pure pieces, as 645 : 100; and the assay gives, by a proper management, $63\frac{1}{2}$ parts of tin in 100. Mr. Brunnich mentions this wood-tin also in his Mineralogy among the tin-ores: but the radiated tin-ore of Wallerius, from Siberia, quoted by Mr. Brunnich, is, according to Mr. Romé de l'Isle, not tin-ore, but wolfram.

In

In the *Elémens de Minéralogie* of Mr. Sage this Wood-tin is mentioned under the name of *Mine d'étain en stalactite*. Mr. Romé de l'Isle describes it according to Mr. Brunnich; and in his Mineralogical Tables, which he has annexed to his treatise of the external characteristic signs of minerals, he adds to the denomination of Mr. Sage *hématite d'étain*. Mr. Bergmann also speaks of this mineral in his *Dosimasia viâ humidâ*, in the following words: Nuper variationem in Anglia inventam obtinuimus peculiarem, quae stratis sphaericis contiguis, radiisque e centro prodeuntibus, haematiten fuscum omnino refert.

The following description, which was communicated to me in writing by Inspector Werner of Freyberg, our master in minerography, cannot fail to be particularly agreeable to mineralogists.

C

Stannum

Stannum ochraceum cornubiense

“The colour of it is hair-brown, sometimes lighter, sometimes darker; when lighter it approaches somewhat a yellow grey, and sometimes an Isabella yellow. Not unfrequently there are two or more shades of this colour in one piece in the small parallel spherical striae, which run across it.

It has never been found but in small pebble-like pieces, which are partly much rounded, and partly still retain their former irregular angular figure, or the splintered form of their fragments, with angles only a little rounded. There are found, though but rarely, pieces which shew on one or more sides their original small spherical external protuberances.

The surface of these pieces is only a little rough.

The external surface of this fossil has only a small degree of lustre, but internally it is somewhat brighter, and in general of a common lustre.

It

It is very tender; the structure is fibrous; the fibres are straight, and commonly divergent from one side.

It breaks partly into regularly angular, partly into small, splintered and wedge-like pieces. It is found mostly in somewhat large and long angular and grain-like pieces, with a resplendent surface: often also in distinct conchoidal pieces, the convexity of which is towards the surface, covered with the spherical protuberances; sometimes it is found entire; when scratched, it shews a yellowish grey trace; it is hard, but may be cut with a file; its gravity is always considerable; sometimes great, and sometimes very great.

“The brown haematites is the only fossil to which it bears a resemblance; but there is a sufficient difference with respect to external figure and to colour both in mass, and when reduced to powder and, above all, with respect to hardness and weight, to enable us to

distinguish them: is it likewise distinguished by a somewhat less internal gloss, and by the greater tenderness of its fibres. *."

With this excellent description of Mr. Werner may be compared the annexed drawings of the three principal specimens of my collection, which could be more easily taken of this fossil than of many others, on account of the apparent organical structure, and want of metallic splendor.

The crystals of quartz, which intersect most specimens of this ore, lead us to suspect that the vein has been quartz; and this is rendered more probable by a piece I have, which has quartz upon both sides of it.

* The above description, though translated with fidelity, may, perhaps, give the reader less satisfaction than he would expect from Mr. Klaproth's character of it: this, in some measure, is owing to the want of an English technical language correspondent to the German one; and, perhaps, in a greater measure to Mr. Werner's attempting to distinguish nicely degrees of qualities which do not admit of measurement.

As

As a kind of Wood-tin, I am inclined to consider another still more rare species, called Shot-tin, which is brought from Maddern. This is only found in small separate hemispheres of the size of a divided shot. The surface is smooth, and brown, but the inside, or the nucleus, is of a light-brown, and of white yellow colour, and slightly radiated. These stalactitical hemispheres, which, as one may see, have been fixed to other bodies, are similar to the small spherical protuberances of Wood-tin, excepting that the latter are not so hemispherical, but flatter.

Sulphurated tin-ore from Cornwall.

At Huel Rock in Saint Agnes, there has been found a metallic vein, nine feet wide, and twenty yards beneath the surface. The constituent parts of this ore, although experiments had been made upon it, were still unknown. Mr. Raspe, who now lives in Cornwall, is the first who discovered

vered this unknown ore to be Sulphurated tin.

The first, and, until now, the only instance of a native sulphurated tin, is mentioned by Mr. Bergmann. He received it under the name of antimony from Siberia, and the specimen was only of the size of a hazle-nut. As sulphurated tin-ores then are so very scarce, an account of the existence of a large vein in Cornwall cannot fail to be agreeable to mineralogists.

My specimens consist of the compact ore, only here and there are marks of growan, which is the matrix of it. The colour of this ore is, in general, a blueish white, approaching a steel-grey, and comes near the colour of grey copper ore. Its cohesion is in several places interrupted by cracks, often scarcely perceptible, filled with a very thin layer of yellowish and greenish clayey earth: from this cause the external texture seems lamellar, but the fresh fracture is generally irregularly angular. The metallic
splendor

splendor alternates in some specimens with dull grey and blackish spots. It is not considerably hard, but very brittle. The specific gravity varies according to the quantity of metal it contains: those pieces which are more pure and white, and which are the richest of tin, are as 435 : 100. Excepting copper-pyrites, which is interspersed in small particles through it, no foreign body is mixed.

As I am not acquainted with the experiments of Mr. Raspe, by which he thought himself intitled to declare it sulphurated tin-ore, I will communicate in the following pages the analysis I have made, which shew it to consist of sulphur, tin, copper, and some iron. The mixture is so exact and intimate, that the way of powdering and washing, which otherwise is very proper in tin-ores, is of no use. Mr. Raspe proposes to name this ore *bell-metal ore*; which denomination would be more just if there were a larger proportion of copper to the tin.

COPPER-ORES.

Cornwall is not only possessed of rich tin-mines, but also of very rich copper-mines, which produce copper ores of various forms, species and varieties.

Native copper is found in very considerable quantity at Cape Lizard, between the rocks near the sea-shore in filiform branches, and veins of some thickness, contained in blackish serpentine, mixed with brownish red, and covered externally with a greenish nephrites, partly adherent to it, partly loose upon it. In the same rocks also native copper in large lumps has been found.

Huel Virgin produces in a considerable quantity native copper, which shoots into branches of various directions, which seem to be formed of small rhomboidal crystals, interspersed with quartz crystals, of which often only the impressions are to be seen in the native copper of the two specimens I have from this place; one weighs

weighs three quarters, the other one pound and a half; but there has been found native copper in lumps of from twenty to thirty pounds in weight. How rich the mines of Huel Virgin are, may be perceived in general from this, that only in the month of March, 1785, they produced 1400 tons of rich copper-ore; each ton containing twenty hundred weight.

I possess from the same place, as also from Carrarach, which is contiguous to Huel Virgin, and which is no less rich, a specimen of crystallized native copper, with transparent vitreous copper ore, of a ruby colour, crystallized in octoedres: but this fine red crystallized vitreous copper ore begins to be scarce.

Near to the copper vein at Carrarach is found compact native copper, of a spherical form, in lumps, which either is still metallic, or is beginning to be transformed into red copper-glass, imbedded in decayed granite.

Native

Native copper, of a tender and moss-like form, united to ruby vitreous copper ore, crystallized in rhombs, is found in the clefts of mountains, composed of Killas, at Poldory. Very small particles of native copper are interspersed through Gossan at Kastle Adit.

On some parts of the native copper-ores from Poldory and Huel Virgin, is found calciform - copper - ore, sometimes only in a loose form, and covering them like sand, sometimes of a compact structure, and adhering strongly to them. The former kind is generally black, the latter of a brownish red, often approaching to the metallic splendor of copper. One may generally observe in these ores from Cornwall various gradations, calciform copper-ores, vitreous copper-ores and native copper: but I do not pretend to assert whether the metal is reducing or calcining.

Of sulphurated copper ores, Cornwall has an abundance of various kinds.

Whitish

Whitish grey copper ore, crystallized in small triangular and quadrangular pyramids, whose points are generally truncated, is found along with solid grey copper ore at Poldice and Dol-coth. But the richest copper ores are the solid grey from Treseavean, Retal-lack, Cook-kitchen, Carrarach, Huel Virgin, Redruth. Some of these may be cut with a knife like soft vitreous silver ore, particularly those from Tre-seavean; the analysis of these last is given under No. 3.

Yellow copper ores are found at Poldice, Hallamanning, Dol-coth. From the latter mine, which is 160 yards deep, and yet elevated 60 yards above the level of the sea, the most remarkable is a stalactitical ore, of an hemispherical form (Run-yellow copper) which is often variegated with the colours of blue steel or red copper. Calciform copper ores of great variety are likewise found in Cornwall. The rare crystal-
lized

lized red vitreous copper ore has been mentioned before. Compact red vitreous copper ore, covered with green copper, or mountain green, as likewise with calciform copper, of a vermillion red, is found in crystalized quartz, with tender green mica, at Kastle Adit.

Compact green copper ore, like malachite, mixed with grey copper ore; likewise green velvet-like copper, grown in bunches, is found at Huel Virgin. Green copper ore, of no regular texture, is found in decayed granite at Carrarach; likewise stratified betwixt crystals of quartz, which at the same time are covered with a brownish red, soft, glittering iron-rham, at St. Meuan. Azur copper ore, in quartz, is met with at Huel Virgin and Carrarach.

This mountain of granite at Carrarach, so rich in all kind of copper ores, (for the field-spat having been decayed, and converted into clay, the quartz is rendered more capable of receiving metallic substances)

substances) produces sometimes also the two following crystallizations, the nature of which was till now unknown.

The first of these (which lines the cavities of a crystallized crumbled quartz, partly uncovered, and partly coated with indurated green copper, and also with dark brown velvet-like iron ochre) consists of tender, olive-green coloured spiculae; these are about two or three lines long, and stand straight up either single or fasciculated and radiated. They consist of copper mineralized by the acid of arsenic. When I tried them with the blowpipe, they deflagrated with arsenical smoke, and then fused, forming a button of a grey colour, which when melted again with borax, gave instantly a button of very pure copper.

The other crystals in my specimen, are very small, aggregated dark green cubes with smooth and shining surfaces upon grey copper ore in a mass of crystallized compact quartz with cavities in it.

it. They might be easily taken for small cubes of fluor, but their constituent parts are copper and arsenic. Examined with the blowpipe, they swell in little bubbles, and emit the smoke of arsenic, but not so much as the first mentioned crystals, nor do they run so quickly into a grey metallic button. After this button had been melted with borax, it could be beat out upon the anvil into thin plates; but it was harder and somewhat more pale than pure copper, and had some spots of a steel colour. It would seem therefore that iron is mixed with it.

Besides the tin and copper in which the principal richness of Cornwall consists, it produces also other remarkable fossils.

Galena in large cubes is found at Treseavean with copper pyrites: at Poldice mixed at the same time with cuprous and arsenical pyrites in quartz and killas: and at Penrose there is a rich vein of it which opens upon the surface.

Grey

Grey cobalt ore, either without or with Bismuth, is found at Dol-coth. The chemical analysis of the first kind, which resembles very much in colour, fracture and other external appearances, the cobalt from Rappold at Schneeberg, which is used in manufactures will be given No. 4.

CrySTALLIZED pseudo-galena, or black-jack, mixed with pyrites, is found at St. Agnes. Pyrites or Mundick are to be met with very frequently in different forms: large cubes of pyrites imbedded in granite are found at Wendron.

Penzilly in Breage parish affords haematites of a liver-brown colour mixed with manganese. This fossil, which was sent from Cornwall by the name of liver-coloured Tungsten, is found in a vein of a yellow friable iron-ochre, through which this supposed Tungsten runs in veins of different thickness and position. It is of a liver colour, even fracture, and somewhat fibrous texture. The experiments

ments related under No. 5, will be a sufficient proof, that this mineral is not Tungsten, but manganese mixed with much iron.

Wolfram of a foliated texture united to quartz and white clay, is brought from Poldice. See experiments made upon it under No. 6.

The Asphaltum, or indurated Bitumen, from Carrarach, is remarkable for being found 90 yards deep in granite.

Of the different kind of stones and earths of Cornwall, besides the above mentioned killas and growan, the following are worthy of notice.

Chalcedony from Trevascus. It is found in fine, stalactitical, variously configured pieces formed of thin layers, and is now seldom to be met with.

Steatites or soap rock is found running through serpentine in small shallow veins at Cape Lizard. The finest species of it is white, streaked with veins of a blueish and reddish colour. It is so soft as to be
scraped

scraped by a knife like soap ; but in the fire it acquires a considerable degree of hardness. It is made use of in the manufacture of porcelain, and for this purpose is collected by the managers of the Porcelain manufactory at Worcester, who pay 20 pounds sterling for a tun of twenty hundred weight, because the digging of it, on account of the great brittleness of the serpentine rock, is very dangerous. The analysis of this species is given No. 7.

There is also found a less fine sort with spots of iron ochre, and likewise a variety of a reddish brown colour, mixed with green. That of Ruan minor is of a greyish white, and light slate blue colour. There is found also a whitish steatites grown through with calcareous spar, which gives to the former a smooth shining fracture.

White Porcelain earth: this is produced by the decomposed feldspar of a decayed granite which fills the valleys in Cornwall,

wall, and is separated by washing. That from St. Stephens is principally used for porcelain : of the other less pure sorts very good crucibles are made.

Talc and asbestos are found in the serpentine rock near Cape Lizard.

Mica of a grey colour and lamellar texture is to be met with at St. Dennis ; and Black Bar-Shoerl imbedded in granite is found at Logan Rock near the Lands-end.

This short mineralogical view of my collection of Cornish fossils, must not be, as I have already mentioned, considered as complete, many additions being necessary to it.

I shall now proceed to give an account of some chemical analyses, which I have made of them.

CHEMICAL

CHEMICAL EXPERIMENTS.

WOOD-TIN.

§ I.

THE obstinacy to solvents which distinguishes tin ores in general when examined in the liquid way, I have found in a great degree in the Wood-tin.

(a) The simple acids had very little effect. Aqua regia made a perceptible solution: 60 grains of Wood-tin reduced to the most subtile powder, and digested in 3 ounces of it in a strong heat long continued, lost only 5 grains. I tried therefore the method recommended by Mr. Bergmann.

(b) Upon two drams of finely powdered wood-tin, I poured one ounce of concentrated acid of vitriol, and digested it for

some time in a boiling heat; afterwards I added cautiously two ounces of concentrated marine acid, digested it again, and diluted it with water: when the solution was clear, I poured it off from the residuum deposited at the bottom. I repeated this process twice with the residuum, each time with half the quantity of the acids. The undissolved residuum weighed 98 grains, and retained its appearance. The solutions poured together had a somewhat gold yellow colour: some of it examined with phlogisticated alkali, discovered iron by its blue colour. The rest of the solutions being saturated with vegetable alkali gave a precipitate of a dirty white colour, which weighed when dry 27 grains. This precipitate examined with the blow-pipe, shewed a tendency to melt and form a metallic globule, but this was again instantly calcined. Melted with microcosmic salt, a greyish white porcelain-like scoria was formed: with borax it would not unite, but remained diffused

diffused through the borax glass. Upon the remaining precipitate marine acid was poured, which soon dissolved it; from this solution, after having been diluted with water, tin leaves were deposited upon a cylinder of zinc.

(c) In order to know, if wood-tin could be made to dissolve more easily in acids by melting it first with alkali, one dram of it was melted with three drams of fixed vegetable alkali, and the light brick-coloured mass, which was produced washed in water, and the solution filtered. The ley which passed clear through the filtre was not changed in its appearance by acids; and theedulcorated and dried powder, which was less coherent, and of a redder colour, was not more soluble than before.

(d) One dram of pulverized wood-tin was mixed with three drams of sal ammoniac and sublimed in a small matrass. The sublimate was of a greyish yellow colour. The residuum was again sublimed

with three drams of sal ammoniac, which was coloured like the first. The remaining wood-tin had lost only a few grains in weight. A solution of the sublimate in water was tinged blue by the phlogisticated alkali : the fixed alkali precipitated a little light grey not coherent powder, which appeared an impure calx of tin.

§ 2.

These experiments indeed shew this fossil to be a calx of tin, united with a small portion of iron, similar to the common tin-stones : but to know the quantity of metal contained to it, a reduction was necessary. And as in assaying tin ores the produce depends very much upon circumstances, the reduction of this ore was tried under the following variations :

(a) Wood-tin, 1 dram.

White glass, 2 drams.

Calcined borax, 1 dram.

Powdered charcoal, 10 grains.

This

This mixed and melted in a strong fire during an hour, in a crucible lined with charcoal, and to which a cover was luted, (as has been done in all the following experiments,) gave a dirty olive coloured scoria, in which the reduced globules of tin lay dispersed; these were collected by powdering and washing, and weighed 10 grains and a half.

(b) As I had often found the sal sedativum to be a remarkably good flux for reducing metals, I tried it in this instance, and mixed

Wood-tin, 1 dram.

Sal sedativum, 3 drams.

Powdered charcoal, 10 grains.

This mixture, melted likewise during an hour, gave a blackish lamellar porous scoria, mixed with charcoal: the tin globules contained in it, separated by powdering and washing, weighed 19 grains.

(c) I was led to suppose an hour to be too long for keeping it in a melting state,

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because

because a part of the reduced tin was again calcined, and mixed with the scoria; for this reason I repeated the last experiment, but with this difference, that I kept the mixture only half an hour in the fire, and the result shewed, that I had approached the proper time; for now I obtained $30\frac{1}{2}$ grains of pure silver-coloured tin globules, upon which the loadstone had no effect.

(*d*) Under the same circumstances I made two other assays, one with the tin ore from Schlackenwalde in Bohemia, and the other with the pure crystallized tin-stone from Mengarn in Cornwall. The powdered tin ore from Schlackenwalde gave 16 grains of globules of tin of an iron-grey colour, and very attractable by the magnet.

e Afterwards I tried the reduction only by the addition of phlogiston without any flux. I mixed 1 dram of wood-tin with an equal weight of colophony in a crucible covered with powdered charcoal, and let it remain half an hour in a melting

ing heat. I found at the bottom of the crucible an uniformly melted regulus of tin, the weight of which was 26 grains, and I collected, by washing the powdered charcoal, 11 grains more in small globules, and half a grain of black flocculi very attractable by the magnet. The inner surface of the cover was sprinkled with small globular particles of tin, which could not be collected, but which I thought equivalent to 1 grain.

The reduction by phlogiston alone is therefore the best, and proves wood-tin to be one of the richest tin-ores, for there are very few other tin-ores, which assay-
ed give $63\frac{1}{2}$ in 100.

§ 3.

This tin seemed to be nevertheless somewhat more brittle and hard than pure tin. When dissolved in marine acid a residuum was left of blackish, shining scales,
three-

three-fourths of a grain in weight. Of this examined with the blow-pipe a part rose in arsenical smoke, and left one-eighth of a grain of iron attractable by the magnet. To half of the solution in marine acid was added phlogistated alkali; by which the calx of tin was precipitated of a white colour with some spots of blue. From the other half, saturated with volatile caustic alkali, the tin was precipitated likewise in form of white calx: after standing for some time a small cloud of yellow calx of iron hung over it.

SULPHURATED TIN-ORE.

In those pieces I have examined, which were indeed of the same vein, but taken from different parts of it, I found, according to the difference of colour and splendor, the proportion of the component parts something different, so that the surest way of ascertaining the true proportion

proportion is to take the mean result of many experiments.

§ 1.

Half an ounce of this tin-ore was heated red hot in a small glass retort. When cold, about two drops of a fluid, which proved to be volatile sulphureous acid, were found in the receiver. In the neck of the retort was a little grey yellow sublimate, about one-fourth of a grain. This sublimate carefully collected and placed upon a red hot charcoal, smelled and burned at first like sulphur, but afterwards a smell of arsenic was perceived. The residuum had lost 3 grains.

§ 2.

Two drams of this ore were slowly heated in an earthen vessel, till no smell
of

of sulphur could be perceived. It was changed by it into a red calx, and weighed 2 drams, 20 grains, though it had lost its portion of sulphur, which is considerable. This calx mixed with an equal weight of calcined borax, half its weight of white glass, and a fourth part of colophony, and melted in a strong heat, during half an hour in a crucible lined with charcoal, and covered with common salt, gave a small regulus of a grey colour, 10 grains in weight, but which was so brittle that it flew in pieces when gently struck with a hammer. The rest of what was reduced was in very small globules, which lay scattered in the powdery scoria mixed with charcoal.

The result of this experiment proves, that the common dry way of trying this ore is totally improper.

§ 3.

(a) Upon half an ounce of tin ore finely powdered was poured 4 ounces of aqua regia, composed of two parts of marine and one part of nitrous acid. The metallic part was mostly dissolved in 24 hours without heat, and the sulphur rose to the surface. After the solution was digested again in a sand bath for two hours, it was diluted with water and filtered. There remained two grains of sandlike earth: the separated sulphur weighed 75 grains. But the sulphur wanting a pure yellow colour, appeared still to contain some metallic parts: it was slowly deflagrated, and left 17 grains of a black grey residuum.

(b) To the filtered metallic solution I added fixed vegetable alkali. But observing the first precipitate, which had a whitish colour approaching to yellow, to
be

be different from the next, which was of a greenish colour, I desisted as soon as the precipitate began to shew this greenish colour. I collected the whitish precipitate by a filtre,edulcorated and dried it; having dissolved it again in marine acid, I put into this solution a cylinder of zinc. The tin precipitated itself on the zinc in a metallic state, but was mixed with a portion of copper. This metallic precipitate was therefore dissolved again in marine acid, by which means the copper remained undissolved, and the filtered solution containing the tin was now clear and colourless. Having put a cylinder of zinc into it, the tin was immediately precipitated in metallic shining flocculi, which when washed and dried weighed 48 grains, and when melted in a small crucible covered with charcoal formed globules.

(c) The second half of the metallic solution, which remained after the separation of the first precipitate, was completely

pletely saturated with fixed vegetable alkali, whereby I obtained the remaining portion of copper in a precipitate of a pure green colour. Beingedulcorated and dried, it was with those 17 grains of metallic particles which were left after deflagration of the sulphur, and with the copper which remained by depurating the tin (in the former experiment) strongly heated and then digested in nitrous acid. After a strong digestion, the blue solution of copper was separated by the filtre from the insoluble residuum, and the copper was precipitated by a polished iron, and weighed 53 grains.

(*d*) The insoluble residuum which was of a white grey colour, and weighed twenty-three grains, was heated in a crucible with a little wax: the magnet attracted three grains. The other 20 grains appeared to be calx of tin, which are nearly equivalent to 16 grains of tin in its metallic form.

The

The result of this analysis is consequently

Pure sulphur	—	—	58 grains.
— Tin	—	—	64
— Copper	—	—	53
Calx of iron	—	—	3
Earth of the stony matrix			2
		—	
			180

But as there were still 60 grains wanting, I chose the following way, which gave me a much more just result.

§ 4.

(a) Two drams of the same mineral finely powdered was dissolved in $1\frac{1}{2}$ ounce of the above mentioned aqua-regia. There remained undissolved 43 grains of sulphur, which during digestion had formed itself into one mass; some greenish spots shewed that a portion of metal was contained in it. After a gentle deflagration of it in an earthen vessel, there remained 13 grains, 8 grains

8 grains of which were dissolved in aqua regia, and added to the first solution. The insoluble 5 grains were separated by the filtre, and heated along with some wax: the magnet now attracted about 1 grain. The remainder weighed 3 grains, and consisted of argil and filex.

(*b*) To the solution of the metallic part was added fixed vegetable alkali: the precipitate was of a greyish green colour, and after having beenedulcorated and dried, was dissolved again in marine acid, diluted with 2 parts of water, and a cylinder made of pure tin, which weighed 217 grains, was put into the solution. The copper contained in the solution was precipitated in a metallic state. The solution began to lose its green colour from below, till at last all the copper being precipitated, it appeared without any colour.

(*c*) The copper weighed 44 grains. In order to try the purity of it, it was digested with heat in nitrous acid. The

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solution

solution was of a blue colour, and one grain of tin in a white calciform state, was left undissolved. It contained therefore 43 grains of copper.

(d) The cylinder of tin used for precipitating the copper weighed now 128 grains, and 89 grains had been of course dissolved. By a cylinder made of zinc I now precipitated all the tin, which was connected loosely to the zinc in tender leaves and arborescent forms. Being satisfied that all the tin was precipitated, I collected it carefully, washed and dried it. It weighed 130 grains. I then melted it, mixed with tallow and powdered charcoal, and when it was cold, separated the charcoal by washing. With the washed tin globules I found some black flocculi of iron, attractable by the magnet, which weighed 1 grain. This being deducted from the weight of tin, there remained 129 grains. The above 89 grains of the cylinder of tin, used for precipitating the copper, taken then from this sum,

sum, there remained 40 grains; to which must be added 1 grain of tin separated from the solution of copper. The product of pure tin in this experiment is consequently 41 grains.

The results of this process are

Pure Sulphur	—	30 grains
— Tin	—	41
— Copper	—	43
— Iron	—	2
Earth of the stony matrix	3	

—
119

Of the two drams therefore used for this analysis only one single grain was lost.

The reason why I first precipitated from the solution in aqua-regia with alkali, and dissolved the precipitate again in marine acid, was in consequence of knowing, that, when tin is precipitated from aqua regia by zinc, the whole quantity is seldom precipitated in a metallic form; but a considerable part of it is

E 2

corroded

corroded by the nitrous acid, whereby the solution acquires a turbid opal-like appearance, and a jelly-like consistence, which disagreeable circumstance cannot well be corrected. But if a turbidness appears in precipitating the tin by zinc from the marine acid, it is very soon removed by adding some drops of marine acid.

§ 5.

By repeated experiments according to this method I have found that in similar pieces of this ore there is no considerable difference with respect to the proportion of its constituent parts. But in pieces of a different appearance, the break of which is of a darker colour, and without lustre, I found a more considerable portion of iron.

I dissolved half an ounce of this ore in aqua regia, and two different precipitates
were

were made in the manner mentioned in § 2. The first of a white colour, consisting of tin, was strongly heated in an earthen vessel, by which a smell of arsenic was perceived. The whitish colour of calx of tin was changed into a flesh colour, which it generally acquires by being long heated. After some wax was deflagrated with it, it weighed 61 grains, and scarcely one grain was attracted by the magnet. The second precipitate of a greenish colour was likewise strongly heated, and became by this means a black heavy powder. Digested with nitrous acid in a boiling heat the solution became blue. A light brown calx of iron remained, which dried and heated with wax weighed 18 grains, totally attractable by the magnet.

The quantity of iron contained in half an ounce of this ore was 19 grains in a state of phlogisticated calx; so that in the former species there was found a much less portion of iron.

§ 6.

Though in the course of these experiments no sign of silver or lead was discovered, I made, in order to be quite certain, the following trial.

Upon the calcined tin ore, § 1. was poured nitrous acid, which acted with violence, emitting frequent red vapors. Being sufficiently digested, water was added, and the residuum, consisting of sulphur, and calx of tin, separated by the filtre. The clear blue solution was treated with marine and vitriolic acid, and also with some neutral salts containing these acids, without being in the least altered, a proof that no silver or lead was mixed.

§ 7.

§ 7.

The solubility of the tin contained in this mineral in aqua regia and marine acid, which is not the case with that of the common calciform tin ores, or with any strongly dephlogisticated tin calx, is a sufficient proof, that the tin is in this case united to the sulphur, in such a state as to approach metallic tin. I think this in general to be the case with all other mineralizations. The following experiment is still more convincing.

(a) Half an ounce of sulphurated tin ore, mixed with the same quantity of corrosive sublimate, was put into a small retort, a receiver was applied, and the retort placed in a sand bath. When moderately heated, a heavy fluid with white heavy vapors came over, and by increasing the heat, a sublimate of a grey yellow colour, mostly crystallized in

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needles,

needles, was formed in the neck of the retort, and an impure dark grey cinabar was found adhering to the upper part of the retort, beneath the neck.

(b) The fluid collected in the receiver weighed one dram, and was similar in all respects to the butyrum stanni fumans Libavii. One drop of it added to a diluted solution of gold, precipitated a purple powder. The above fluid was diluted with water, and the tin precipitated by fixed vegetable alkali. This very loose white precipitate, washed, and dried, weighed 30 grains.

(c) The sublimate collected from the neck of the retort (a), was triturated and digested with water, and filtered: the residuum weighed, after having been dried, 203 grains. These were dissolved again in aqua regia, excepting a residuum of 15 grains of sulphur: from this solution the mercury was precipitated in a metallic form by copper. The solution in water was precipitated by
fixed

fixed vegetable alkali: the precipitate weighed sixteen grains, and resembled the precipitate of tin, mentioned (*b*), and was added to it.

(*d*) This calx of tin was dissolved again in marine acid, and precipitated from it in a metallic form by a cylinder of zinc. The metallic precipitate, collected, washed, and melted in a small crucible, with some tallow, gave a button which weighed twenty grains. After having been flattened, and cut in pieces, it was digested in nitrous acid, and when completely calcined, diluted with water, and filtered. The solution was then examined with phlogisticated alkali, and some brown flocculi were precipitated; a mark of the tin being still mixed with a small portion of iron.

(*e*) In order to render these experiments more satisfactory, similar ones were made with a pure kind of *zinzwitter*: but in these there was not the least mark of the butyrum stanni, and the corrosive sublimate,

sublimate, mixed with the *zinzwitter*, was sublimed, unaltered, in needle-like crystals; the remaining tin-ore was also not changed.

§ 9.

The most accurate method of analysing this mineral, is that described in § 4. according to which, by repeated experiments, the sulphurated tin-ore from Cornwall, of the pure light coloured kind, was found to contain in a hundred,

Sulphur,	—	—	25
Tin,	—	—	34
Copper,	—	—	36
Iron,	—	—	3
Earth of the stony matrix,			2
		—	
			100

The proportions in the darker varieties of this ore, are somewhat different,

ferent, as they contain about eight parts of iron in a hundred. The very trifling mark of arsenic observed in § 1. deserves no notice.

Grey Copper Ore from Treseaven.

I only mention these experiments as a proof that the moist way of assaying ores is in some cases preferable to the common smelting process. Copper-ores especially, assayed in the dry way, do not give the exact quantity of metal contained in them. This is partly owing to a tendency the calces of copper have to form in a strong heat scoriae, and partly to a dissolution of a portion of the copper by the alkaline fluxes which are usually employed.

The fluxes consisting of glass, borax, and charcoal, recommended by Messrs. Gellert, Tillet, de Morveau, and other metallurgists, give, indeed, more regulus
of

of copper than the common alkaline fluxes: but the analysis of copper ores in the moist way, according to the following experiments, is still the most accurate.

(a) Half an ounce of this copper ore, pulverized, and properly calcined, lost 14 grains. It was then mixed with an equal weight of calcined borax, half its weight of white pounded glass, and 1-4th of rosin; and after all, being gradually heated in a crucible lined with charcoal, covered with common salt, was melted in a strong heat during half an hour. Under an uniformly fused blackish grey scoria was found a globule of copper, which weighed 71 grains, which is $29\frac{7}{12}$ in 100.

(b) Upon half an ounce of the same copper ore, calcined, was poured two ounces of strong concentrated acid of vitriol. The mixture was distilled to dryness: what remained was washed with water, the solution filtered, and the copper

per precipitated by a polished iron. The quantity of copper now obtained was 135 grains, or $56\frac{1}{4}$ in 100. These 135 grains melted with the above-mentioned flux, gave a globule of copper which weighed 133 grains.

Grey Cobalt Ore from Dol-côth.

§ 1.

(a) Half an ounce of this cobalt-ore reduced to a subtile powder, was gradually dissolved in aqua regia, made of equal parts of nitrous and marine acid. The solution was briskly performed, very frequent red vapors being expelled, and only a grey muddy residuum, $1\frac{1}{2}$ grain in weight was left; this deflagrated upon charcoal with a flame, and smelled at first like sulphur, but afterwards like arsenic: some earth remained.

(b) The

(b) The filtered solution, of a brownish colour, was only imperfectly saturated with fixed vegetable alkali. The precipitate of a whitish, approaching to a yellow-ochre colour, was separated by the filtre, and weighed when dry five drams fifteen grains. It contained iron and arsenic: mixed with powdered charcoal, and heated, the arsenic sublimed in thick vapors, and left the iron.

(c) This solution, the arsenic and iron having been separated, was of a pale red colour, and was now completely saturated by the fixed vegetable alkali. The precipitated calx of cobalt was of a reddish grey colour, and weighed whenedulcorated and dried one dram fifteen grains.

§. 2.

(a) One ounce of finely pulverized cobalt-ore was calcined in an earthen vessel

vessel in a strong heat, till no smell of arsenic could be perceived. This calx of cobalt was of a dark brown colour, and had lost exactly the third part of its former weight. It was melted in a crucible, with a mixture of two ounces of black flux, and one dram of rosin, and covered with common salt. A compact regulus of cobalt was obtained, which weighed $158\frac{1}{2}$ grains, after a small portion of $3\frac{1}{2}$ grains of bismuth was separated. The fracture of this regulus of cobalt was of a fine granular texture, interwoven with some tender striae, like a net. Small pieces were attractable by the magnet, but upon larger ones, some grains in weight, the magnet had no effect.

(b) The pulverized regulus of cobalt was put by small portions into nitrous acid, which dissolved it very briskly; the solution was then digested for some time, diluted with water, and separated by the filtre from the insoluble light yellow calx of iron. It was of a brown
red

red colour, and afforded a green sympathetic ink, by adding some portion of common salt; a proof that it contained still much iron. After having diluted it with water, I added slowly fixed vegetable alkali in solution, and took care to stop when the precipitate began to change its colour from that of a muddy calx of iron to a violet, and the solution had obtained a clear rose colour. This solution freed from all precipitate of iron by the filtre, and employed as a sympathetic ink, gave a beautiful sky-blue. It was now completely saturated with alkali, and the pure calx of cobalt was precipitated of a violet colour, and whenedulcorated, dried, and finely levigated, weighed 70 grains. Two grains of it mixed with one ounce of glass frit, gave, when properly melted, a very fine sapphire blue glass.

(c) The iron which had been united with the regulus of cobalt, and which was precipitated from the solution in
nitrous

nitrous acid, in part spontaneously, and in part by alkali, wasedulcorated, dried, and made red hot along with some fat. It weighed 156 grains, and was totally attractable by the magnet. By other experiments I have found the proportion of the calx of iron, made attractable by heating it, to the iron in a metallic state to be as 7 to 5. As, therefore, those 156 grains of phlogisticated calx of iron are equivalent to $111\frac{1}{2}$ grains in a metallic state, the quantity of pure cobalt metal free from iron obtained from one ounce of this cobalt ore, the regulus of which weighed $158\frac{1}{2}$ grains, must be 47 grains.

(d) I observed in the following experiments a remarkable difference between the violet calx of cobalt obtained from the regulus, and that from the cobalt ore (§ 1. c). A small quantity of the first, dissolved in smoking marine acid, gave a beautiful sapphire blue colour

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I had never before seen in a solution of cobalt. The other precipitate of cobalt, prepared from the ore in solution, with the same acid, gave, on the contrary, a dark grass-green colour.

The cause of these appearances seemed to be the smoking principle of the marine acid. For as soon as the solution was diluted with water, the colours of both disappeared, and changed to a light rose red. With marine acid, which was not so concentrated as to smoke, the solutions obtained immediately a red colour, as if vitriolic or nitrous acid had been used.

§ 3.

From the external appearance, as well as from the analysis, I imagined this cobalt from Cornwall, might give, like those employed in Saxony, a very fine smalt. The result of experiments
made

made in different proportions, confirmed this opinion.

- (a) Calcined cobalt, 1 dram,
Sand from Freyenwalde, prepared,
Fixed vegetable alkali, of each 3
drams.

These well mixed, and kept during two hours in a melting heat in a crucible, to which a cover was luted, gave a very dark glass; from which was obtained a fine dark azure blue, by levigating it, and washing it with water, so as to separate the less heavy parts.

(b) Half a dram of calcined cobalt, mixed with the former quantity of sand and alkali, and treated in the same manner, gave a deep blue smalt, similar to the above, and even of still greater vivacity.

(c) With the same quantity of sand and alkali, was mixed 15 grains of calcined cobalt. This gave likewise a fine lively blue colour, very little lighter than the former.

These experiments prove at the same time that a portion of iron is not injurious to the preparation of smalt, if the cobalt is free from other substances.

The supposed Tungsten from Cornwall.

§ I.

The true tungsten, or lapis ponderosus, which now begins to be so very scarce, is known by its being fusible, by a proper addition of microcosmic salt, with the blow-pipe, and making a clear blue glass, but still more certainly by its assuming a yellow colour when powdered, and digested with nitrous or marine acid.

Another, not less sure way, to distinguish true tungsten from ponderous spar, quartz, and other stones, is by the hydrostatical balance. The specific gravity of tungsten in pure, compact, white pieces,

pieces, dug formerly at Schlackenwalde and Schoenfeld, I found as 6015 : 1000.

Upon examination, the mineral sent from Cornwall for tungsten proved not to be it. The following experiments will shew of what it consists.

§ 2.

A part of this mineral, separated from the adherent ochraceous iron ore, was mixed with an equal weight of fixed vegetable alkali, and exposed in a crucible to a strong heat. It did not melt, but was reduced to a powder, which while red hot, was poured out of the crucible, and obtained when it became cold, a dirty dark green colour, like the chamæleon minerale. By pouring water upon it, it shewed the same variety of colours as the alkalized manganese: the colour of the solution was at first grass-green, but soon after violet

in different shades. After being filtered and saturated with vitriolic acid, the colour became crimson, and a small brown precipitate was let fall, which, collected, proved to be calx of manganese, without any tungstenic acid.

The dark brown powder which remained upon the filtre after the solution of the calcined mass, being edulcorated, dried, and heated, was totally attracted by the magnet.

This analysis sufficiently shews this mineral to be iron mixed with manganese; on which account I have named it, "Liver-coloured haematites, mixed with manganese in ochraceous iron-ore."

Wolfram from Poldice.

§ 1.

Four ounces of wolfram well separated from its stony matrix, were powdered,
and

and mixed with an equal weight of fixed vegetable alkali, and melted in a crucible. It soon fused in a strong heat, and a smell of arsenic was perceived. This dark green scoria-like mass was poured upon a flat stone, reduced to a powder, and digested for a proper time in distilled water in a matrafs, and then filtered.

§ 2.

The residuum consisting of a loose black powder, which weighed 10 drams, was again mixed with equal parts of fixed vegetable alkali and heated. Now no fusion could be produced, but, it became only red hot. The water poured upon it afterwards dissolved nothing, and took up only the alkali. This residuum when dried, proved to be a phlogisticated calx of iron, attractable by the magnet.

§ 3.

The filtered colourless solution of the wolfram melted with alkali, was saturated by nitrous acid, by which the acid of wolfram was precipitated in form of a white tender earth. This precipitate washed and dried gave a yellowish white considerably heavy powder, and weighed 15 drams. If the acid of wolfram be precipitated when the solution of the alkalized wolfram is still warm, the mixture obtains a blue colour, which it loses again on growing cool.

§ 4.

The properties of this acid, and the effects it produced upon other substances, I found in general to agree with what Mr. *Scheele* has said, who is the discoverer of
it,

it, and whose merit in chemistry is so well known. However, what Mr. *Scheele* affirms, that this acid of wolfram or tungsten is soluble in 20 times its weight of water, is true only when the acid of wolfram is still moist; for if it is in a state of dry powder, scarcely 150 times its weight of water are sufficient to dissolve it. This acid is not strong, having more of a disagreeable metallic than sour taste. Its solution in water is very little altered by the phlogisticated alkali, but does form after some time a little white precipitate. With lime-water and the solutions of calcareous and ponderous earth in marine acid, it forms an opal colour, and a white precipitate. The solutions of copper and iron are not altered by it; but silver, mercury, and tin, are precipitated white by it from their solutions. The precipitate of tin shews after some time a bluish green colour: If the dry acid of wolfram be employed, the solution of tin in marine acid is rendered

dered totally blue. With a solution of hepar sulphuris made with fixed alkali it forms a green, and with that of hepar sulphuris volatile a blue colour: the precipitates of both are blue.

§ 5.

Half an ounce of the dry acid of wolfram was digested for some time with 2 ounces of concentrated marine acid; it assumed a dark yellow sulphur-like colour, and lost 1 dram of its weight. The marine acid separated by the filtre, and the water used for edulcorating the yellow residuum were mixed and saturated by fixed vegetable alkali: the solution became turbid, and formed a jelly-like precipitate, which, when dried, weighed 2 grains. In an open fire it was in part volatile with the smell of arsenic, and a scoria containing some iron was left. This shews that the white acid of wolfram still contains

contains some arsenic, which is also proved by other experiments. It melts with the blow-pipe, and yields a smoke of arsenic, and has the appearance of a steel-grey crystallized scoria: on the contrary, the acid of wolfram, of a yellow colour, prepared by digestion in marine acid, is infusible with the blow-pipe, and shews no mark of arsenic, but the yellow changes into a bluish colour.

§ 6.

It is a peculiar property of this acid when melted with the microcosmic salt, or other salts containing the phosphoric acid in a proper proportion, to give them a fine blue colour, but it does not give a blue colour to borax. I made the two following experiments:

(a) Prepared filix,

Calcined borax, of each 2 drams,

Acid

Acid of wolfram, in a dry state,
15 grains.

(b) Prepared filex, 1 dram,
Glacial phosphoric acid, 2 drams,
Acid of wolfram, in a dry state,
10 grains.

I found both melted to a glass in a proper degree of heat: (a), was of a fine crystalline colourless glass; (b), was also of a clear, transparent glass, but tinged with a fine sapphire blue colour.

As therefore cobalt is not the only substance which communicates a blue colour to glass; this circumstance must not be overlooked, in determining the dispute with respect to the material the ancients used in preparing their blue glass; cobalt, as some assert, having been unknown to them.

§ 7.

These properties shew evidently the acid of tungsten or wolfram to be metallic. If the supposition be true, that every substance of a metallic nature is capable of affording a regulus, we should expect to obtain one from this acid. Nevertheless, Mr. De Luyart is the only person who has succeeded in producing a regulus. My experiments have hitherto failed, though I have attempted the reduction by different methods and different fluxes, both in common melting furnaces, and even in those used for making porcelain at Berlin.

I just mention, that in these experiments I always made use of the yellow acid of wolfram; for I should fear that the metallic globule obtained from the white unpurified acid, might be produced by a portion of iron and arsenic combined.

Soap-

Soap-rock from Cornwall.

§ 1.

One ounce of this soap-rock in pure pieces was heated to redness in a glass retort. In the receiver was found a small quantity of pure tasteless water. It had lost one dram 15 grains of its weight, and had acquired a darker colour, and a considerable degree of hardness. Pulverized and mixed with two ounces of fixed vegetable alkali, it was heated red hot in a crucible of porcelain, but not suffered to melt: after this, it was triturated with distilled water, and a superabundant quantity of marine acid to saturate the alkali was added to it, and sufficiently digested.

§ 2.

§ 2.

In the solution a precipitate was formed of a considerable quantity of white, loose, yellow-like earth, which separated, edulcorated, dried, and calcined, weighed 204 grains. It proved to be pure siliceous earth.

§ 3.

The solution being filtered and crystallized, phlogisticated alkali was added to it, when it gave a blue precipitate, which collected upon the filtre, was edulcorated and dried. After heating it to redness with some wax, it weighed seven grains, and it was totally attracted by the magnet.

It would be an error to suppose these seven grains the true quantity of iron contained in this soap-stone. For, though
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the phlogisticated alkali I use is so well prepared, that pure marine acid poured upon it does not shew the least mark of blue during the first 24 hours, it nevertheless adds a portion of iron when used to precipitate iron dissolved in acids. On account of this circumstance, very great circumspection is required, in determining the exact quantity of metal contained in a solution, and precipitated by phlogisticated alkali.

I have found 100 parts of iron in a metallic state, dissolved in marine acid, and precipitated by pure fixed vegetable alkali, after beingedulcorated and heated, to give 140 parts of phlogisticated calx of iron attractable by the magnet: and the same quantity of iron, precipitated by crystallized phlogisticated alkali, perfectly well prepared, the blue precipitate beingedulcorated and heated, to give 260 parts of phlogisticated calx of iron. The quantity of phlogisticated alkali required for precipitating those

100 parts of iron, dissolved in marine acid, must then precipitate from itself so much iron as is equivalent to $85\frac{5}{7}$ parts of iron in a metallic state, or 120 parts of calx of iron phlogisticated by heating and attractable by the magnet.

According to these experiments, the quantity of iron in a state of phlogisticated calx contained in one ounce of soap-rock is $3\frac{1}{17}$ grains.

§ 4.

The earths of the solution were precipitated by crytallized fixed vegetable alkali, and, whenedulcorated and calcined, weighed 192 grains. A proper quantity of distilled vinegar, somewhat concentrated by frost, was added to this precipitate, and after digestion the solution was filtred. The earth remaining upon the filtre was dried again, and calcined,

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and

and then weighed 93 grains: it was afterwards treated with 3 times its weight of concentrated oil of vitriol, and evaporated nearly to dryness in a sand-bath, then re-dissolved in water and filtered. There then remained 26 grains of an indissoluble earth, which was filex: when this was mixed with mineral alkali, and melted with the blow-pipe, it swelled and gave a clear globule of glass.

I have several times observed siliceous earth along with other earths dissolved in acids: this should suggest how cautious a chemist ought to be in analyzing different kinds of stones and earths.

§ 5.

The vitriolic solution contained therefore the remaining 67 grains, which, precipitated by alkali and examined, was argillaceous earth.

§ 6.

§ 6.

Of the first quantity of earth, the weight of which was 192 grains (§ 4.) 99 grains were dissolved in acid of vinegar. Being precipitated by fixed vegetable alkali, and examined with the vitriolic acid, it was found to be magnesia.

§ 7.

One ounce or 480 grains of soap-rock contained therefore, according to the preceding experiments,

			grains.
Calcined earth of filex (§ 2.)	204 gr.	}	230
— — — — (§ 4.)	26 —		
— — — argill (§ 5.)	—		67
— — magnesia (§ 6.)	—		99
— calx of iron (§ 3.)	about		4
			—
			400
			The

The loss of weight in air and water expelled by calcination	—	—	75
			—
			475
Lost during this process	—	—	5
			—
			480

F I N I S.

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